PB-216 909

PARTICLE COUNTER AND SIZE ANALYZER

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1 December 1959

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Instrumentation Unit
Air Pollution Engineering Research

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of State Services
Division of Engineering Services
Robert A. Taft Sanitary Engineering Center
Cincinnati 26, Ohio
December 1, 1959

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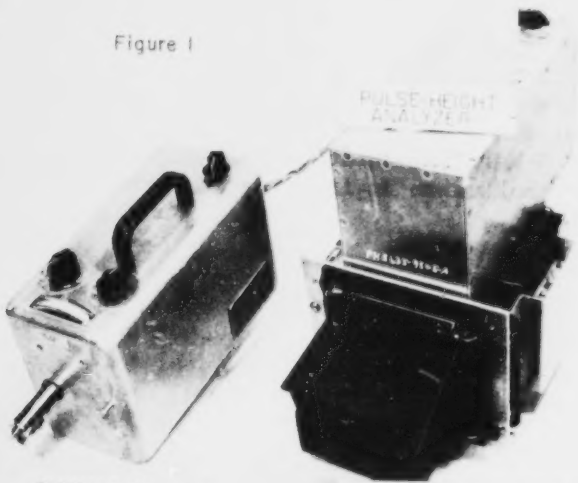
PARTICLE COUNTER AND SIZE ANALYZER*

The particle counter and pulse-height analyzer (Fig. 1) is designed to measure particle concentrations and size distributions of aerosols in the atmosphere and of solid particles or liquid droplets in gases. The instrument is portable and battery operated, employing transistor circuitry. The counter measures 14-1/2" x 5" x 8-7/8" and weighs 10-1/2 lbs. The analyzer measures 13-1/2" x 9-1/4" x 12-3/8" and weighs 22-1/2 lbs.

Figure 1



PARTICLE SIZE RANGE: 0.3 to 10 microns diameter.

DILUTION FACTORS: Calibrated at 1 and 10.

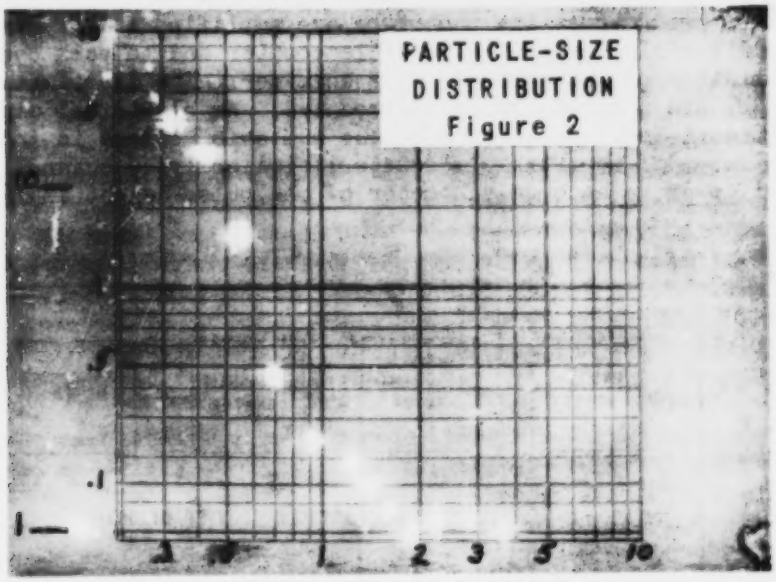
FULL SCALE PARTICLE CONCENTRATION RANGES: Particles may be counted at a rate of 10 and 100 per second corresponding to an undiluted concentration of 1 and 10 million particles per cubic foot, respectively. For a dilution factor setting of 10 these correspond to 10 and 100 million particles per cubic foot, respectively.

Particle count may also be accumulated over a period of time for concentrations less than 1 million particles per cubic foot. Maximum reading time is 2 minutes which gives a full scale value of 0.5 million particles per cubic foot. With the log scale this gives a minimum readable concentration of 5 thousand particles per cubic foot.

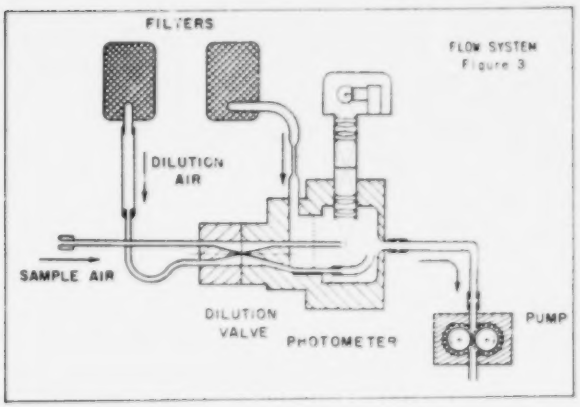
MANUAL SIZE ANALYSIS: The particle counter may be operated independently to obtain a count of particles above a given size. The cut-off is adjustable from 0.3 to 2 microns by a manually operated discriminator. A series of readings at various cut-off sizes will give a cumulative distribution of particle count vs. size.

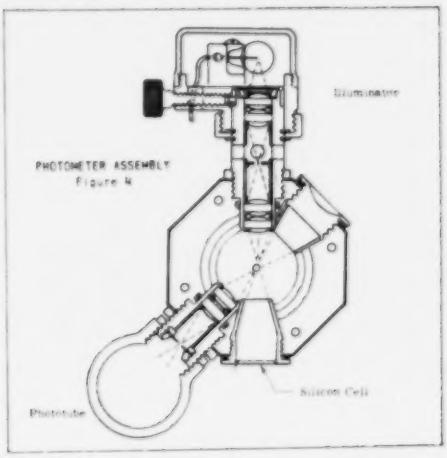
*Developed by Southern Research Institute for the United States Public Health Service under contract No. SAph 70964.

AUTOMATIC SIZE ANALYSIS: Automatic size analysis is obtained by operation of the particle counter in conjunction with the 12 channel pulse-height analyzer. A size distribution histogram of the analyzer output is displayed on the screen of a multi-channel galvanometer. There are also simultaneously displayed the values for the dilution factor and the total particle concentration. The entire display may be "frozen" at any instant to permit photographing the information (Fig. 2).



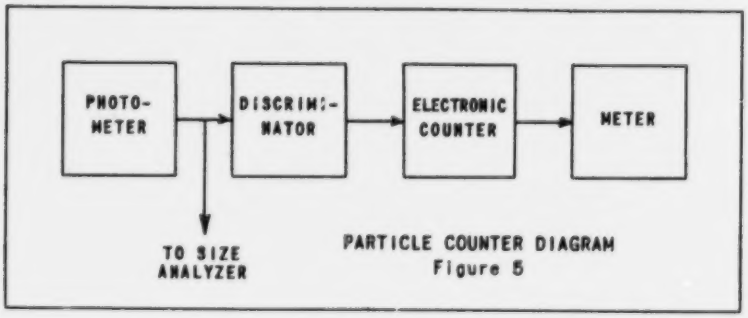
FLOW AND OPTICAL SYSTEMS: Air is drawn through the flow system (Fig. 3) at a rate of 17 cc/min. by a small positive displacement gear pump. Dilution air is obtained from the environment through a high efficiency filter. The dilution valve gives the desired ratio of dilution to sample air. Filtered air surrounds the sample air stream to prevent dispersion of particles in the photometer head and to maintain laminar flow of the sample stream through the optical volume. For concentrations within full scale range, particles are viewed one at a time as they are drawn into the illuminated optical volume of 0.5 microliters (Fig. 4). The scattering angle is 135° from the incident light beam.



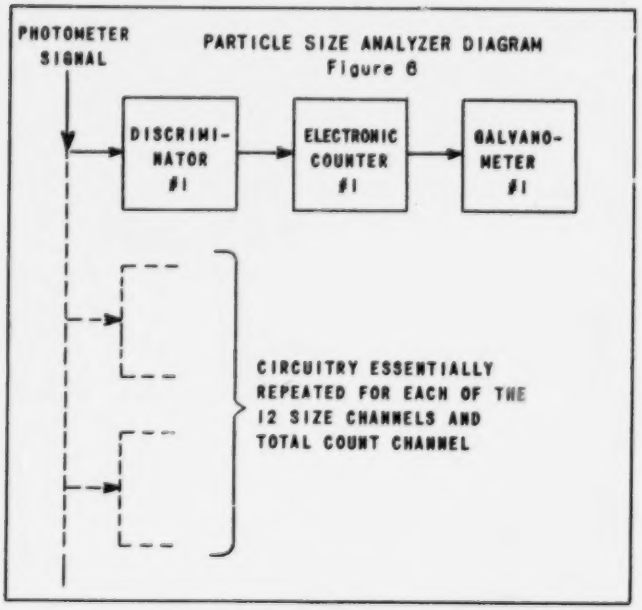


The photo-multiplier tube produces an electrical pulse of approximately 1 millisecond duration from the light scattered by each particle. These pulse amplitudes are analyzed for electrical size distribution and displayed in terms of particle size diameters, based on calibration with monodisperse polystyrene spheres.

ELECTRONIC SYSTEM: Simplified block diagrams of the electronic system of the counter and analyzer are shown in Figures 5 and 6. Pulses produced at the phototube are amplified and applied to the one discriminator of the particle counter and to each channel discriminator of the particle size analyzer. The discriminator output pulses are then amplified and counted. An electrical signal proportional to the logarithm of the number of pulses is indicated on the meter of the particle counter; similarily, a channel signal is used to drive each galvanometer of the pulse-height analyzer.



PARTICLE COUNTER DIAGRAM
Figure 5


PHOTOMETER SIGNAL
DISCRIMI-NATOR #1
ELECTRONIC COUNTER #1
GALVANO-METER #1
CIRCUITRY ESSENTIALLY REPEATED FOR EACH OF THE 12 SIZE CHANNELS AND TOTAL COUNT CHANNEL

PARTICLE SIZE ANALYZER DIAGRAM
Figure 6

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